Network Science Collaborative Technology Alliance

Overview

TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.

February, 2010

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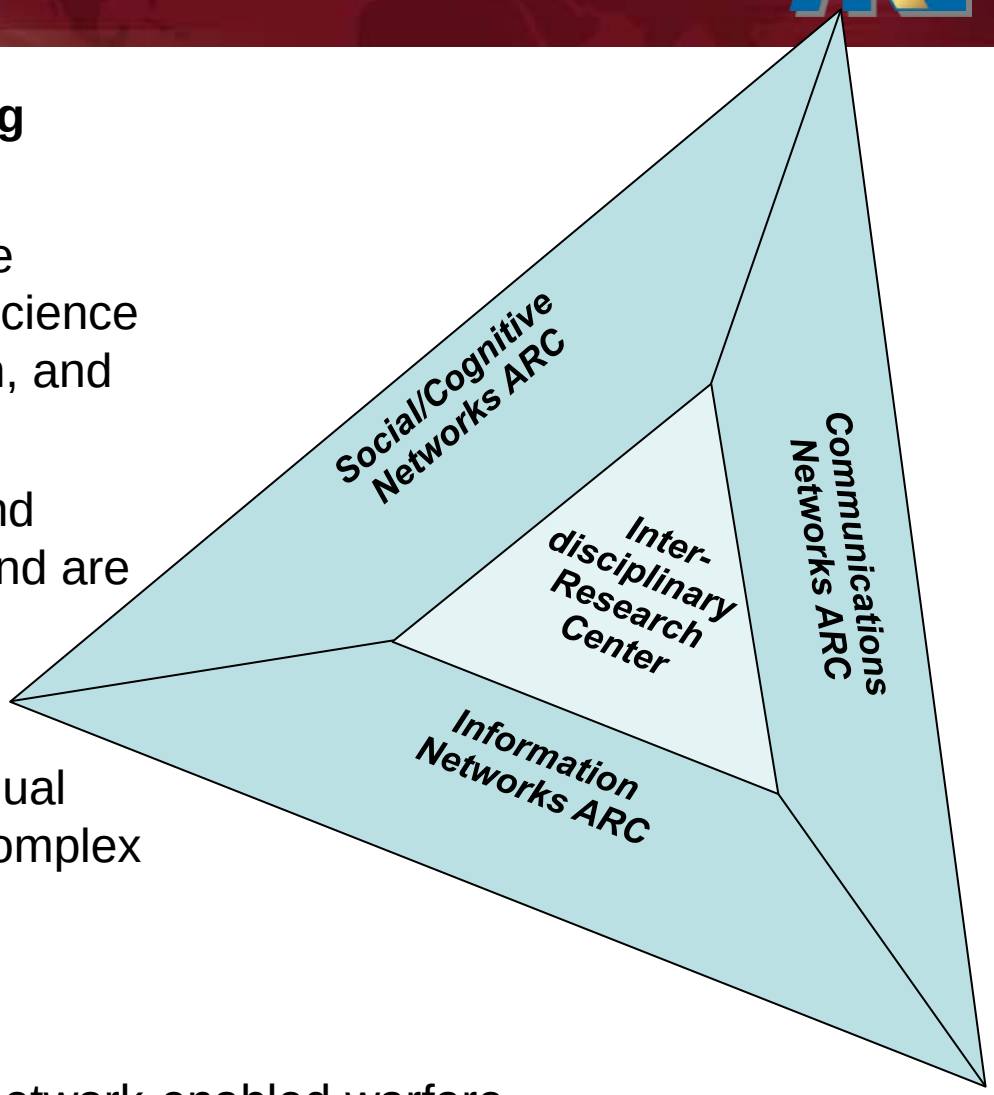
What is Network Science Collaborative Technology Alliance?

- A flagship program of the US Army Research Laboratory
- A collaborative research alliance of academia, industry, and government, across organizations, technical disciplines, and research areas
- Establishes four closely collaborating Network Research Centers:
  - Information Networks Academic Research Center (INARC),
  - Communications Networks (CNARC),
  - Social-Cognitive Networks (SCNARC),
  - Interdisciplinary Research Center (IRC)
- Initial funding awarded in September 2009
- A 5-year program with a potential 5-year extension

NS CTA Objectives

- **Perform foundational, cross-cutting research on network science:**
  - A fundamental understanding of the interplay and common underlying science among social/cognitive, information, and communications networks
  - Determination of how processes and parameters in one network affect and are affected by those in other networks
  - Prediction and control of the individual and composite behavior of these complex interacting networks



- **Resulting in:**
  - Optimized human performance in network-enabled warfare
  - Greatly enhanced speed, precision and control of complex military operations

Network Science CTA Consortium

	IRC	CNARC	INARC	SCNARC
Principal Member	BBN Tech	Penn State	U Illinois-Urbana Champaign (UIUC)	Rensselaer Polytechnic Institute (RPI)
General Member (HBCU/MI)	UC-Riverside	CUNY	CUNY	CUNY
General Member	U Delaware	USC	UC-Santa Barbara	Northeastern Univ
General Member	ArtisTech	UC-Davis	IBM	IBM
General Member		UC-Santa Cruz		

Why Network Science?

- The exceptional importance of networks transpired in the last 20 years, with powerful phenomena like Internet and irregular warfare
- Network Science is the youngest of recognized sciences -- emerged only in the last 10 years (seminal paper – 1999)
- Networks of all kinds--biological, social, computer--are in a unique class of creatures, which live their own mysterious lives: evolve, change, and behave in little-understood ways
- Network science studies fundamental laws of evolution and behaviors of “living” networks, treating them as holistic organisms

What's Different about this Program?

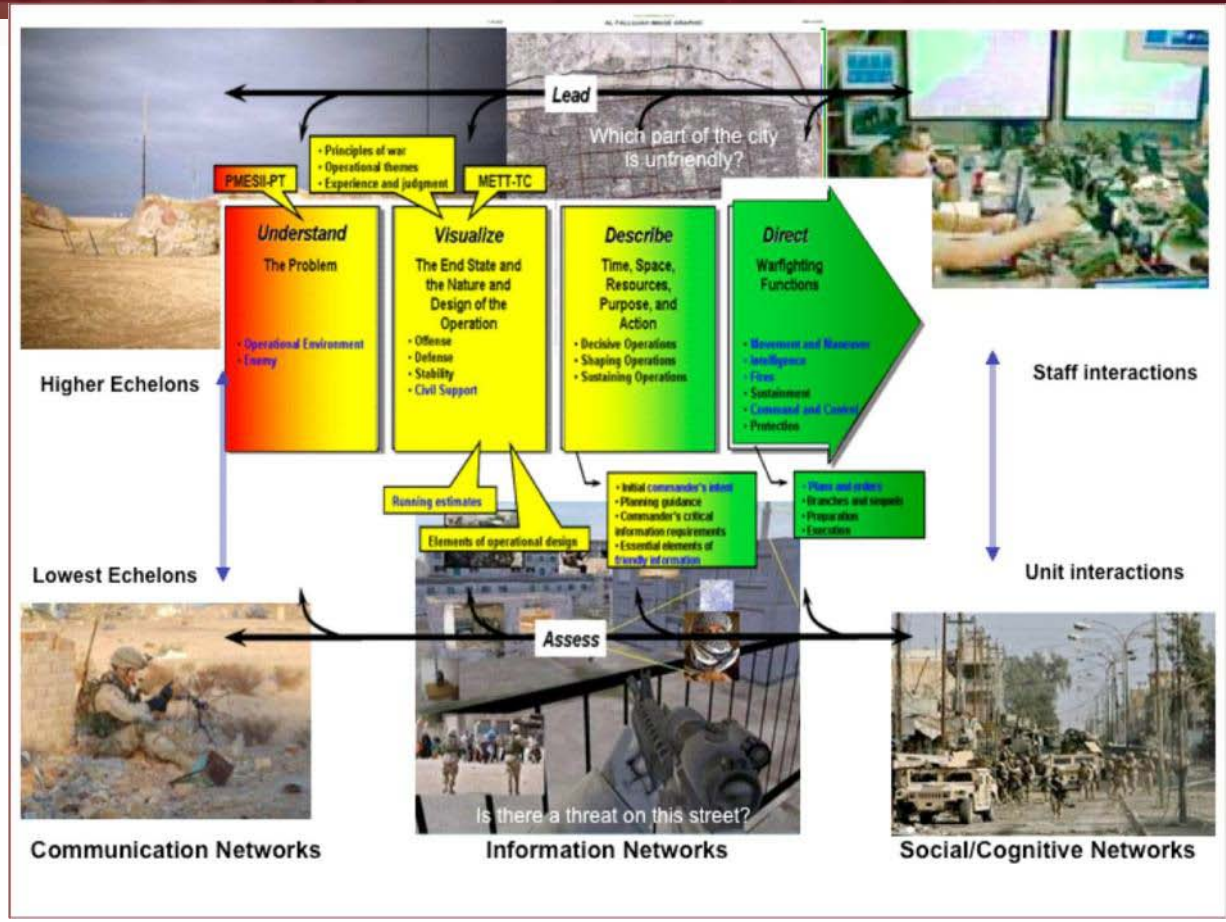
- The first and only program to study mutual interdependency and relations of three dissimilar (and most influential) genres of networks: social, information, communications

- The most powerful and Army-relevant phenomena emerge in intertwining of social, information, communications; not in one of them individually.

- Uniquely organized as 4 collaborating centers to balance (a) in-depth expertise in each network genre and (b) relations, dependencies and mutual influences of three genres.

Network Science and Network-Centric Warfare

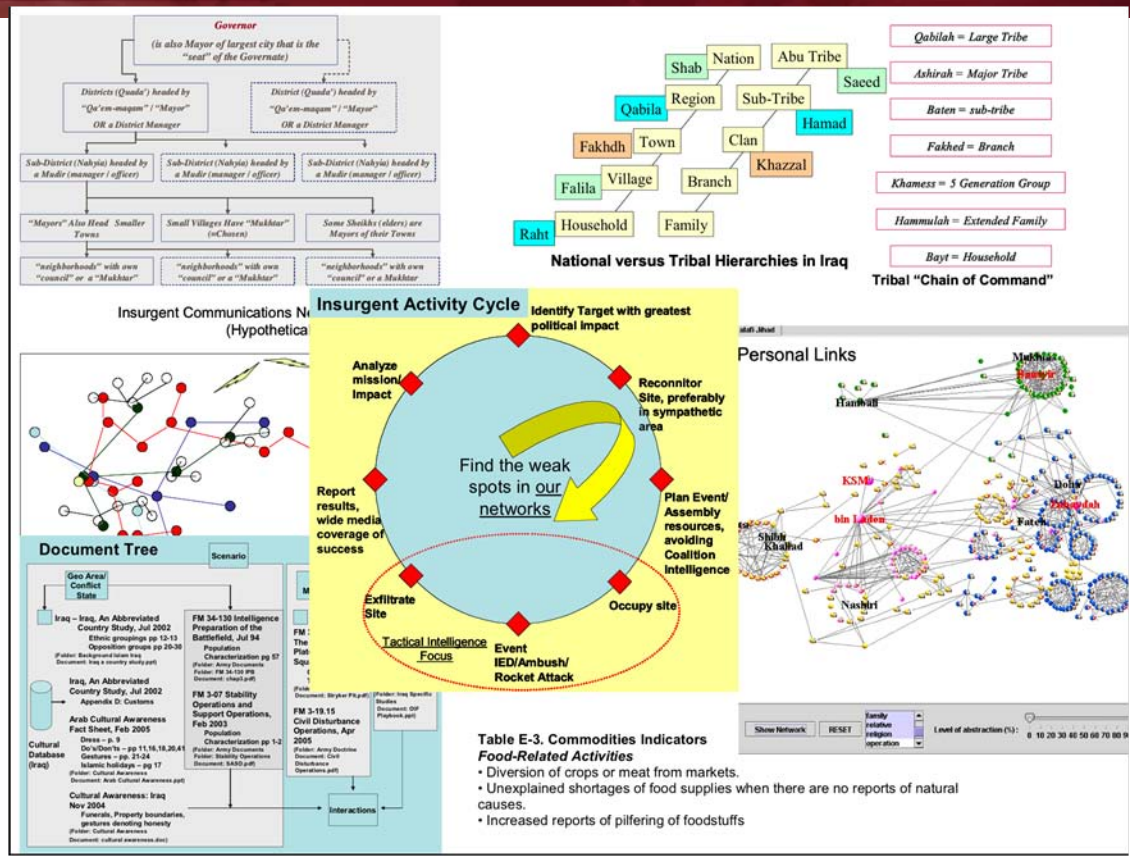
- NCW depends on complex interactions of social–cognitive (warriors, relations, decisions), information (reports, intel, prior knowledge), and communications networks
- What are fundamental limits of information (not bits) transfer?
- How to anticipate and manage information sharing (latency, accuracy, completeness)?
- How to anticipate and manage cognitive processes and knowledge formation?



How to mitigate propagation and snow-balling of errors and mis-interpretations? How to minimize effects of information attacks and loss of trust?

Network Science and Counter-Insurgency Warfare

- Insurgency depends on interactions of social-cognitive (tribes, groups, leaders, relations, perceptions), information (news, propaganda, beliefs) and comms (high and low-tech) networks
- How to anticipate and influence effects of information propagation in a network of population groups, tribes, etc?
- How to manage the evolution of population networks' trust and support to insurgent networks?



How to detect, anticipate and impact the information, decision, and structural evolution of insurgent networks?

Organization

Network Science Collaborative Technology Alliance

Collaborative Alliance Manager

Alex Kott (ARL-CISD), Robert Cole (CERDEC)

Other Leadership Roles

Experimentation

- Brian Rivera (ARL-CISD)
- TBD (CERDEC)

Trust CCRI

- Jerry Powell (ARL-HRED)

EDIN CCRI

- Dave Dent (ARL-CISD)

Interdisciplinary Research Center (IRC)

Ananthram Swami (ARL-CISD)

Will Leland (BBN)

Communication Networks ARC

Greg Cirincione (ARL-CISD)

Tom LaPorta (PSU)

Information Network ARC

Lance Kaplan (ARL-SEDD)

Jiawei Han (UIUC)

Social/Cognitive Network ARC

Jeff Hansberger (ARL-HRED)

Bolek Szymanski (RPI)

Interdisciplinary Research Center (IRC)

Foci: set research directions for the three ARCs; research how global network properties or behaviors can be composed from local properties; manage the reporting, financial, and administrative matters of Consortium; manage the NS CTA Facility with a distributed multi-user experimentation environment that can be accessed by all members; transition of research results from the Alliance

Director: Will Leland, BBN Technologies
Email: wel@bbn.com
Government Lead: Ananthram Swami
Email: aswami@arl.army.mil

Project and Leads:
Project R2, Methods for Understanding Composite Networks: M. Faloutsos, UCR

Project R3, Characterizing the Interdependencies Among Military Network Components: Mike Dean, BBN; J. Hendler, RPI

Project R5, Experimentation with Composite Networks: C.Partridge, BBN; J. Hancock, ArtisTech

Information Networks Academic Research Center (INARC)

Focus: foundation, methodologies, algorithms, and implementations for effective, scalable, hierarchical, dynamic and resilient information networks

Director: Jiawei Han, UIUC
Email: hanj@cs.uiuc.edu
Government Lead: Lance Kaplan
Email: lkaplan@arl.army.mil

Project and Leads:

Project I1, Distributed and Real-time Data Fusion and Information Extraction: Charu Aggarwal, IBM; Tarek Abdelzaher, UIUC

Project I2, Scalable, Human-Centric Information Network Systems: Xifeng Yan, UCSB

Project I3, Knowledge Discovery in Information Networks: Jiawei Han, UIUC

Social/Cognitive Networks Academic Research Center (SCNARC)

Focus: theory, measures, and understanding of social and cognitive networks as applicable to both individual and organizational decision making in the context of networked information systems and fused, networked knowledge

Director: Boleslaw Szymanski, RPI
Email: szymansk@cs.rpi.edu
Government Lead: Jeffrey Hansberger
Email: jeff.hansberger@us.army.mil

Projects and Leads:
Project S1, Networks in Organization: Ching-Yung Lin (IBM), Kathleen Carley, IRC (CMU)

Project S2, Adversary Social Networks: Detection and Evolution: Malik Magdon-Ismail (RP), P. Pirolli, INARC, PARC)

Project S3, The Cognitive Social Science of Net-Centric Interactions: Wayne Gray (RPI), J. Hansberger, ARL

Project S4, Community Formation and Dissolution in Social Networks: Gyorgy Korniss (RPI), Prasant Mohapatara, CNARC (UC Davis)

Communications Networks Academic Research Center (CNARC)

Focus: foundational techniques to model, analyze, predict, and control the behavior of secure tactical communication networks as an enabler for information and command-and-control (C2) networks

Director: Thomas F. La Porta, Penn State
Email: tlp@cse.psu.edu
Government Lead: Greg Cirincione
Email: cirincione@arl.army.mil

Projects and Leads:

Project C1, Modeling Data Delivery in Dynamic, Heterogeneous, Mobile Networks: A. Yener/R. Govindan, Penn State/USC

Project C2, Characterizing the Increase of QoI due to Networking Paradigms: T. F. La Porta, Penn State

Cross-Cutting Research Issues (CCRIs)

- **A core component of the NSCTAs new way of conducting network science research**
- **CCRIs require a joint collaborative approach by multidisciplinary researchers to make fundamental advances**
- **CCRIs must be identified, formulated, researched, and evaluated**
  - Should be focused on issues that are fundamental to understanding how information, social/cognitive, and communication networks contribute to mission effectiveness
- **Should lead to deep persistent, and meaningful collaboration among Centers**
- **Should harmonize vocabularies, ontologies, metrics, structures, and processes to build understanding across technical disciplines and research areas**

CCRI: Trust in Distributed Decision Making

Foci: composite trust and trustworthiness among multiple entities; trust propagation across networks of multiple genres; multidimensionality of trust and trustworthiness; computing levels of trust

Coordinator: Sibel Adali, RPI
Email: sibel@cs.rpi.edu
Government Lead: Jeff Hansberger,
Email: jeff.hansberger@us.army.mil

Projects and Leads:
Project T1, Trust Metrics, Estimation, and Presentation: Dakshi Agrawal, IBM, INARC

Project T2, Trust impact on network: Sibel Adali, RPI, SCNARC

Project T3, Network impact on trust: Prasant Mohapatra, UC, Davis, CNARC

CCRI: Evolving Dynamic Integrated Networks (EDIN)

Foci: joint representation and modeling of integrated networks; dynamics and evolution of interacting and integrated networks; analysis and prediction of an integrated network's behavior; design and control of an integrated network; intervention in complex systems of adversary networks

Coordinator: Prithwish Basu, BBN
Email: pbasu@bbn.com
Government Lead: David Dent, ARL
Email: dave.dent@arl.army.mil

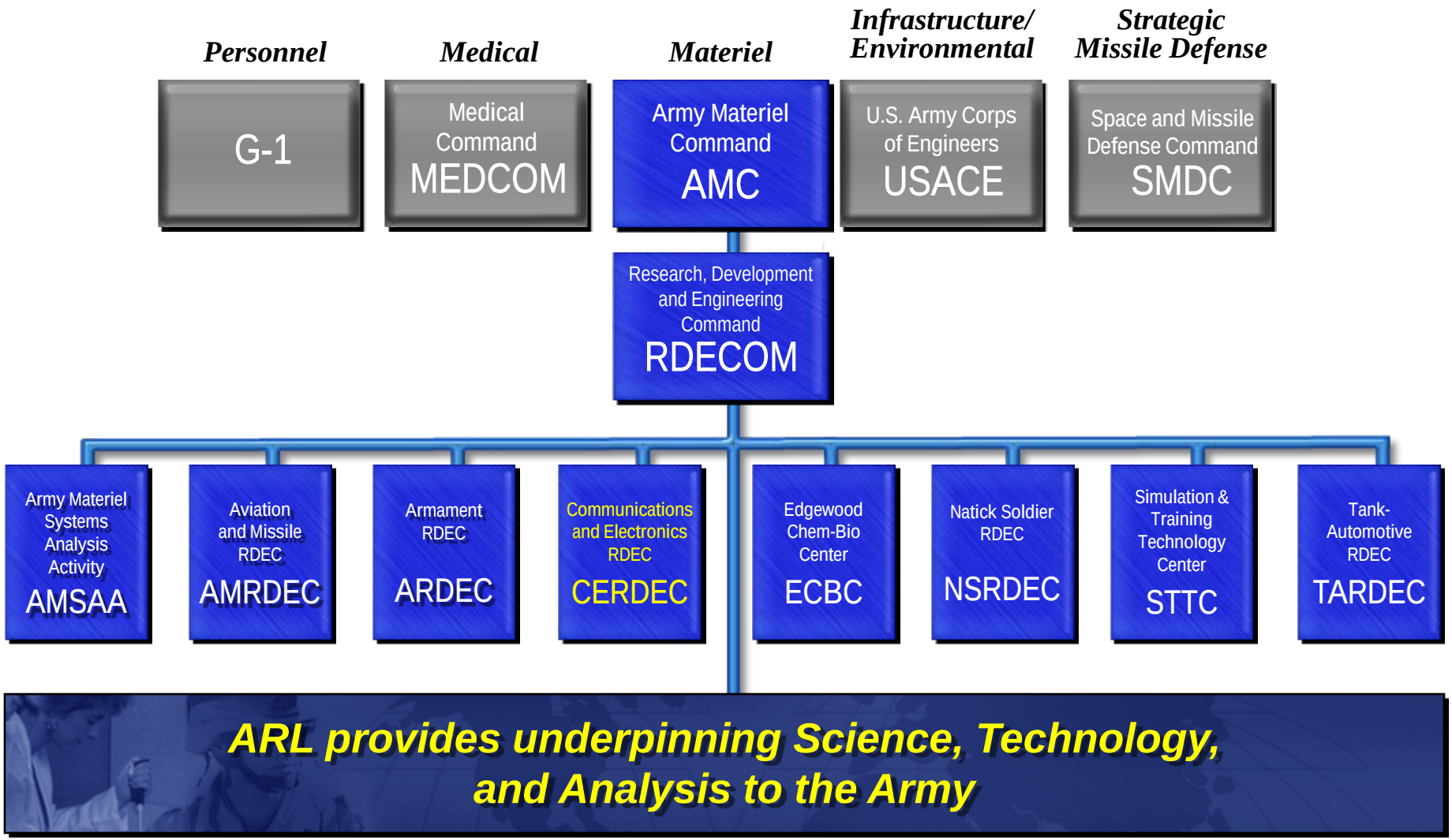
Projects and Leads:
Project E1, Ontology and Shared Metrics for Dynamic Composite Networks: Prithwish Basu, BBN (IRC); James Hendler, RPI (IRC, SCNARC)

Project E2, Mathematical Modeling of Composite Networks: J. J. Garcia-Luna-Aceves, UC Santa Cruz (CNARC); Prithwish Basu, BBN (IRC)

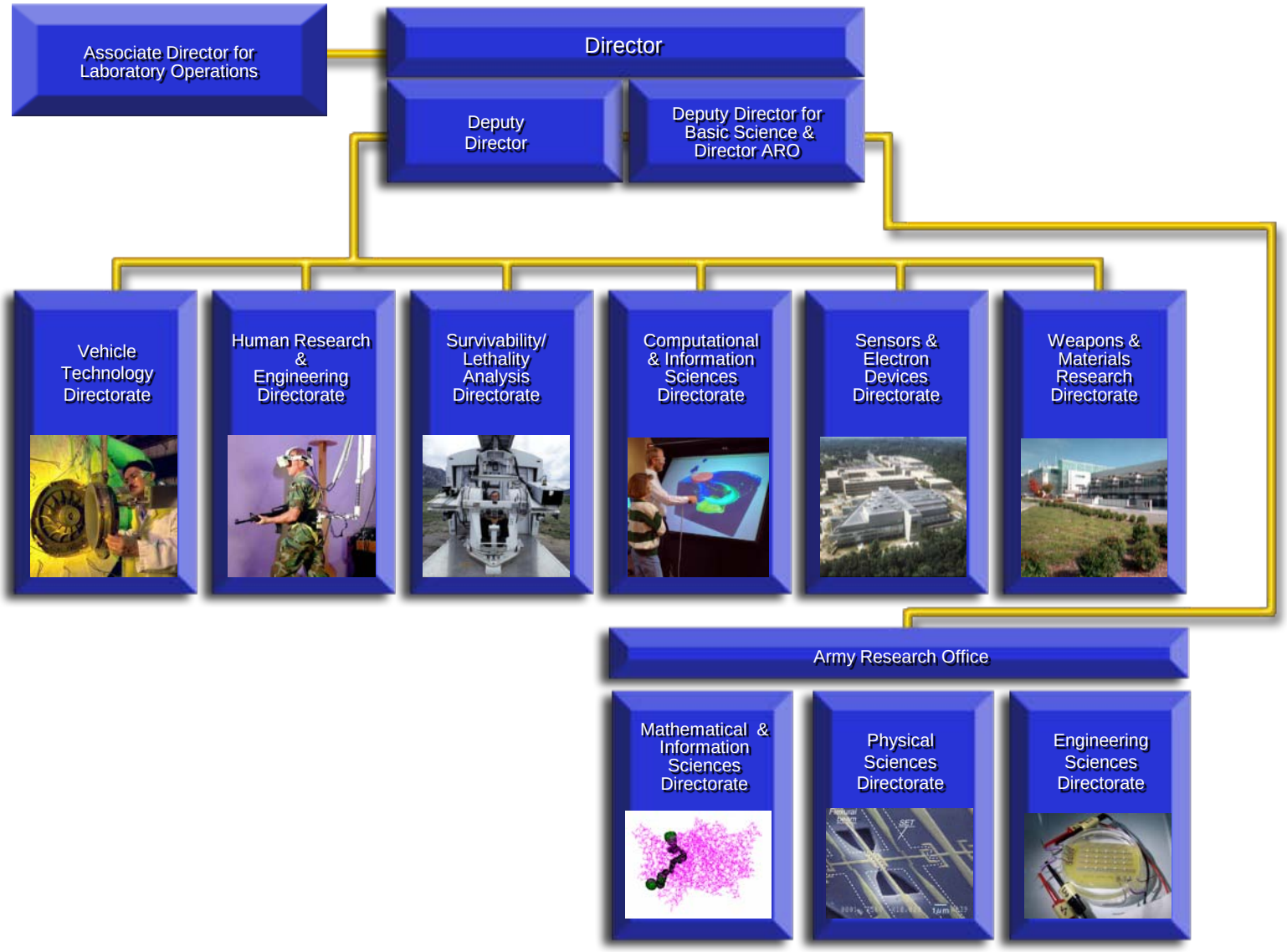
Project E3, Structure and Co-evolution of Composite Networks: Ambuj Singh, UC Santa Barbara (INARC); Boleslaw Szymanski, RPI (SCNARC)

Project E4, Modeling Mobility and its Impact on Composite Networks: Tom La Porta, Penn State University (CNARC)

Army S&T Performing Organizations



U.S. Army Research Laboratory



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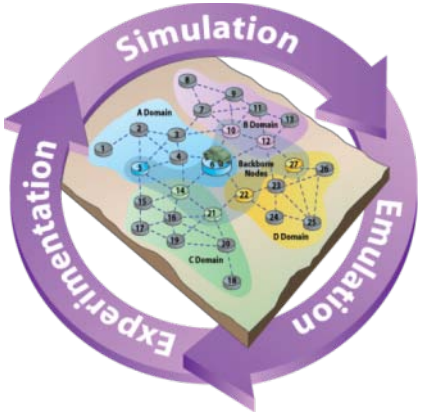
Related ARL Programs

Cognition/Neuroergonomics CTA

- **Explore the neural representations of command-level decision-making**
- **Identify most important factors**
- **Validate neural processing associated with using networked information**



ITA in Network & Info Sciences

- **Distributed decision-making to improve coalition operations**
- **Analyzes cultural differences between coalition forces & their operational context**
- **Focus on rapid assembly of heterogeneous *ad hoc* teams**

HPC Mobile Network Modeling Institute

- **HPC software to analyze MANETs in complex environments**
- **Links simulation-emulation-experimentation cycle**
- **Significantly improve evaluation scalability & fidelity**